

## **Has digital culture really changed how learners think and learn?**

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Twenty first century life has become a digital experience but many educational organizations lag behind the propensity for digital immersion as shown by individuals in their leisure time. Recent surveys of technology use report that 99% of teenage boys and 94% of teenage girls play computer games in their leisure time (Lenhart et al, 2008). This predisposition towards digital activity as a leisure pursuit, it has been suggested, has fostered two cultures; one of digital natives, the other of digital immigrants (Prensky, 2001a; 2001b).

Commentators claim that prolonged digital immersion can trigger major changes in behaviour and cause individuals to think and learn differently (Donaldson, 2006; Feiertag & Berge, 2008; Prensky, 2001a; Robinson, 2007). Brain malleability (Nisbett, 2001; O'Boyle & Gill, 1998) is identified as the explanation for cognitive differences between digital natives and digital immigrants (Prensky, 2009; 2001a; 2001b; Oblinger, 2004). However, in reality we know little about how digital immersion actually affects cognition or educational experiences (Bennett, Maton & Kervin, 2008).

Some researchers argue that digital immersion can help to develop visual selective attention, literacy, concentration, comprehension, problem solving, deductive reasoning and academic outcome (Prensky, 2001a; Subrahmanyam, Kraut, Greenfield & Gross, 2000). Others argue, to the contrary, that digital natives have decreased attention spans because they spend large amounts of time skipping from one activity to the next activity or multi-tasking (McHale, 2005).

It is important that educators understand the effect of digital immersion on their learners, especially if educational establishments, such as schools, are to keep pace with the changing digital culture. If contemporary digital culture is having an effect upon cognitive functioning, learned behaviours and learning behaviours it is imperative that educational establishments adapt to the educational needs of the learners.

Our study explored 2 groups of school-aged learners. One group was deemed to be a high digital immersion group and the other group a low digital immersion group. The study's aim

was to study whether cognitive differences and/or educational differences existed between the 2 groups.

Specifically this project investigated:

1. Whether high and low digitally immersed children differ in terms of their attention and concentration.
2. Whether high and low digitally immersed children differ in terms of their reasoning ability.
3. Whether high and low digitally immersed children differ in terms of their attainment on a research task.
4. Whether high and low digitally immersed children differ in terms of their attainment on an Internet fact finding task.
5. Whether high and low digitally immersed children differ in terms of the way they approach and use resources in a research task.
6. Whether high and low digitally immersed children differ in terms of the way they approach and use the internet in an Internet fact finding task.

## **Methodology**

### **Design**

A sample of 224 children from a range of schools across the Canterbury region completed an immersion questionnaire that detailed their digital activities in their leisure time. Forty eight of these children were then selected as the highest and lowest scoring in their respective schools according to an immersion score derived from their responses to the immersion questionnaire. These final 48 children comprised the high (24) and low (24) digital immersion groups for this study. Each group was then given tests of reasoning and attention and was observed completing two educational tasks (a research task and an internet task). Student behavior during the tasks was video-taped and all computer activity was recorded using screen capture technology. Comparisons were then made between the high and low digital immersion groups and their levels of reasoning and attention/concentration. In addition, comparisons between the groups' performance and behaviour on the research and internet tasks were made.

### **Participants**

Two Hundred and Twenty Four participants (139 males, 85 females) aged 10-12yrs from the New Zealand Canterbury region completed a digital immersion questionnaire. Participants

were recruited from 10 primary schools with decile<sup>1</sup> ratings ranging from 2–10 (New Zealand schools are graded on a scale of 1-10 called decile rating that depicts the extent to which a school draws its students from low socio-economic communities). On questionnaire completion a sub sample of 48 participants (24 male, 24 female) were selected to take part in the second part of the study. These students were selected by choosing the highest and lowest scoring students from each school and balancing for gender (24 high, 24 low) on the digital immersion questionnaire (See table 1).

*Table 1: Immersion score range (min=0, max =84) and N differentiated by school attended*

	<i>Low Immersion Range and N</i>	<i>High Immersion Range and N</i>
<b>School A</b>	9-15 (N=3)	54-61 (N=2)
<b>School B</b>	1-10 (N=3)	49-68 (N=3)
<b>School C</b>	7-12 (N=3)	38-51 (N=3)
<b>School D</b>	16-20 (N=2)	38-52 (N=2)
<b>School E</b>	7-10 (N=2)	54-60 (N=2)
<b>School F</b>	9-10 (N=2)	36-48 (N=2)
<b>School G</b>	23-23 (N=2)	26-59 (N=3)
<b>School H</b>	0-7 (N=2)	31-42 (N=2)
<b>School I</b>	4-18 (N=3)	26-48 (N=3)
<b>School J</b>	11-12 (N=2)	48-51 (N=2)
<b>Total</b>	0-23 (N=24)	26-68 (N=24)

## Materials

### *Immersion Questionnaire*

A comprehensive questionnaire was designed to survey the type and extent of digital behaviour that students were engaged in during their leisure time. The questionnaire included a question asking participants to indicate how often they perform the following 28 digital activities:

1. Use a computer for writing blogs

2. Create webcasts or podcasts
3. Listen to or download webcasts or podcasts
4. Use the computer for creating web pages
5. Download pictures from the internet
6. Use the computer for chatting e.g. MSN
7. Use a computer and microphone for talking
8. Download programs from the web
9. Participate in web discussion forums
10. Use the computer to surf the web
11. Play computer games on the internet
12. Use the computer for email
13. Play computer games on a PC or Mac
14. Listen to music on the computer
15. Listen to music on a MP3 player e.g. iPod
16. Use a mobile phone to text
17. Use a mobile phone to talk
18. Listen to music on my mobile phone
19. Use a mobile phone to surf the web
20. Play computer games on a mobile phone
21. Use the computer for writing
22. Use the computer for drawing
23. Use a digital camera
24. Use a digital video camera
25. Use the computer for editing video movies
26. Install computer programs from DVD/CD
27. Use the computer for composing music
28. Play computer games on a console

Students' responses; never, sometimes, often or all the time and responses were coded as never=0, sometimes=1, often=2, all the time=3; thus allowing a minimum immersion score of 0 and a maximum of 84.

### *Reasoning Tests*

A 55 item standardized reasoning skills test booklet developed by the University of Canterbury Centre for Evaluation and Monitoring (CEM) for use with primary aged children was used to assess reasoning skills. The test included simple logic, deductive reasoning and inductive reasoning skills. Twenty two items assessed literacy, 22 items assessed numeracy

and 11 items assessed abstract reasoning (pictorial). Reasoning skills tests are a good ability measure and can be good predictors of academic success.

### *Tests of Attention*

The d2 test of attention (Brickenkamp & Zillmer, 1998) is a timed test of selective attention and mental concentration designed for use with 9-90 year old participants. Items are composed of the letters "d" and "p" with one, two, three or four dashes placed either individually or in pairs above and below the letter. Participants are given 20 seconds to scan each line and indicate all "d's" with two dashes. The test consists of 14 lines of 47 characters each and a total of 658 items. Measures of performance include an index of concentration performance (CP), total number of items correct minus errors (TN - E), and fluctuation rate across trials (FR). Concentration Performance (CP) is the number of correct items minus errors and is a good measure of speed and accuracy of performance. TN-E is a measure of Quantity of work completed after correction for errors and a good measure of Attention/inhibitory control. TN-E is described by the manual as "the total number of items scanned minus error scores..... It is a measure of attentional and inhibitory control and the relationship of speed and accuracy of performance." (Brickenkamp & Zillmer, 1998; p11). Fluctuation rate (FR) shows the discrepancy between the line with the maximum number of items processed and the line with the minimum number of items processed. Extremely high raw scores can suggest an inconsistency in work speed perhaps related to poor motivation.

### *Research Task*

Students were asked to research a particular era in English history and present a report on their findings. They were given 45mins to complete the task and allowed to use any resources that were available in the work room. Resources available included a computer linked to the internet, a printer and numerous books providing information on the topic. The instructions given to the participants are shown in Figure 1. Participants' reports were blind marked by two independent markers. Markers were instructed to allocate one mark for each correct fact about England in 1666. An inter-rater reliability test indicated a reliability coefficient of .96 which is sufficient to indicate that reliability between markers was good.

### *Internet Task*

Students were asked to answer a number of questions about a particular topic using only internet resources. They were given 15mins to complete this task and asked to record their responses. The instructions that were given to the participants are shown in Figure 2.

Participant responses were blind marked by two independent markers. Markers were given specific facts about the invention of the battery that could be used in a student's answer and the number of marks allocated to each fact. An inter-rater reliability test indicated a reliability coefficient of .97 which is sufficient to indicate that reliability between markers was good.

### *Observations*

All student task sessions were video recorded using a Macbook and a camera and were recorded directly to hard disk. Any computer activity undertaken by students was captured using SnagIt8 a commercially produced screen capture program.

### **CONFIDENTIAL MEMO**

Can you help Professor Von Kramer?

Hello my name is Professor Von Kramer I have just built a time machine that will allow me to travel back through time. I plan to travel back in time to the year 1666. From my calculations I think I will be landing in London, England. Unfortunately, I know nothing about the year 1666 and even less about England, so I really need your help.

Can you make a report for me so that I know what to expect when I get there. I need to take lots of things with me in case I get stuck so I need to know lots about what to expect when I get there. To help you to prepare your report that will be useful for me I've listed a few important questions that I need to know the answers to:

- What isn't yet invented or discovered that I should take with me?
- Who are the important people in England in 1666?
- What important things are happening in England/London in 1666?
- What sort of clothes did they wear in 1666?
- What transport do they use in 1666?
- Any other things about where I am going to land and about the year that I'm there that might come in useful
- 

Make sure the report is placed in my box in this room so that I can study it before I leave. You may use anything that is in this room to find the information and to prepare your report.

GOOD LUCK!

*Prof Von Kramer*

Figure 1. Instructions given to participants for completion of the Research Task.

## HELP PLEASE

Hi Again,

Thank you for the information you gave me to help my travel to 1666.

Now I seem to be stuck in the past and I can't get back. I really need your help. I don't have enough power in my transporter's battery to get me home. I've tried asking people here about batteries and electricity but no one seems to understand what I'm talking about. I have enough power to transport me through about 150 years but this won't get me back to my time period.

What I need you to do is to look on the internet for some information about batteries and electricity and answer the following questions for me:

- Why don't people here know about batteries and electricity?
- When were batteries invented?
- Who invented the battery?

When you get this information please send it to me by email at: VonKramer@hotmail.com

(Also, please print out a copy for my assistant)

Please help me it's awful here!

*Professor Von Kramer*

Figure 2. Instructions given to participants for completion of the Internet Task.

## Procedure

Ten Canterbury primary schools agreed to take part in the project and year 6 teachers within these schools were approached and informed of the procedure and purpose of the research. All year 6 children in each school were given information sheets describing the research and parent/guardians and students were asked to complete permission slips. Students who returned permission slips were included in phase 1 of the project and asked to complete the immersion questionnaire. Instructions on questionnaire completion were communicated by the researcher to all participants. Questionnaires were then completed in class with the help of the teacher and the researcher (if required). No time limits were placed on participants for completing the questionnaires and the researcher and teacher checked all questionnaires on collection. Questionnaires were then collated and entered into a spreadsheet for initial

analysis. Sample 2 was selected according to immersion score and balanced by school attended and gender.

In phase 2 of the project participants (N=48) were asked to complete the attention test and the reasoning test. Participants were tested in groups of 4-6 in a separate quiet room within the school and different tests were completed on different days to avoid fatigue effects. Strict test conditions were adhered to and instructions were clearly relayed to students. Participants in each group started the tests together and finished together and then asked to return to their classrooms.

In phase 3 of the project participants (N=48) were asked to attend the work room individually and allowed 45 minutes to complete the research task using the resources provided. At the end of 45 minutes they were stopped and their reports were collected. The internet task was generally completed the day following the research task. A similar procedure was used for the completion of this task with participants attending the work room individually where they were allowed 15 minutes to complete the task and then thanked and asked to return to class.

## Analysis

MANOVA was conducted on the 3 reasoning scores and 3 attention scores as dependant variables with immersion level (high, low) and gender as independent variables. Two univariate analyses of variance were conducted using the research task and internet task attainment scores as dependant variables with immersion level (high, low) and gender as independent variables, final reasoning scores were included as a covariate to control for ability. The research task was analysed by observing the videos of the participants undertaking the task and the following information was collated: percentage of time spent using books, initial medium chosen (book or internet), form of final report (word processed or handwritten), and whether the participant printed any supporting documents. Finally the internet computer logs of 4 high immersion and 4 low immersion individuals were examined qualitatively to establish their internet research skills.

## Results

### *Reasoning and Attention*

MANOVA revealed a significant difference between high and low immersion groups for literacy reasoning ( $F=8.56$ ,  $df=44,1$ ,  $p=0.006$ ) showing that overall low immersion individuals had higher literacy reasoning scores (low  $M=7.6$ ,  $sd=3.7$ ; high  $M=6.2$ ,  $sd=1.8$ ). In addition, a significant difference was found between high and low immersion groups for



fluctuation rate ( $F=5.65$ ,  $df=44,1$ ,  $p=0.022$ ), a measure that indicates the consistency and stability of performance in the attention test. High immersion individuals showed greater inconsistency (low  $M=15.8$ ,  $sd=9.5$ ; high  $M=20.1$ ,  $sd=7.3$ ).

### *Task Attainment*

Results for the two educational tasks tended towards equivalence apart from a significant cross over interaction between gender and immersion level for the internet task ( $F=6.84$ ,  $df=1,39$ ,  $p=0.013$ ). Low immersion males and high immersion females performed best on this task (see Figure 3).

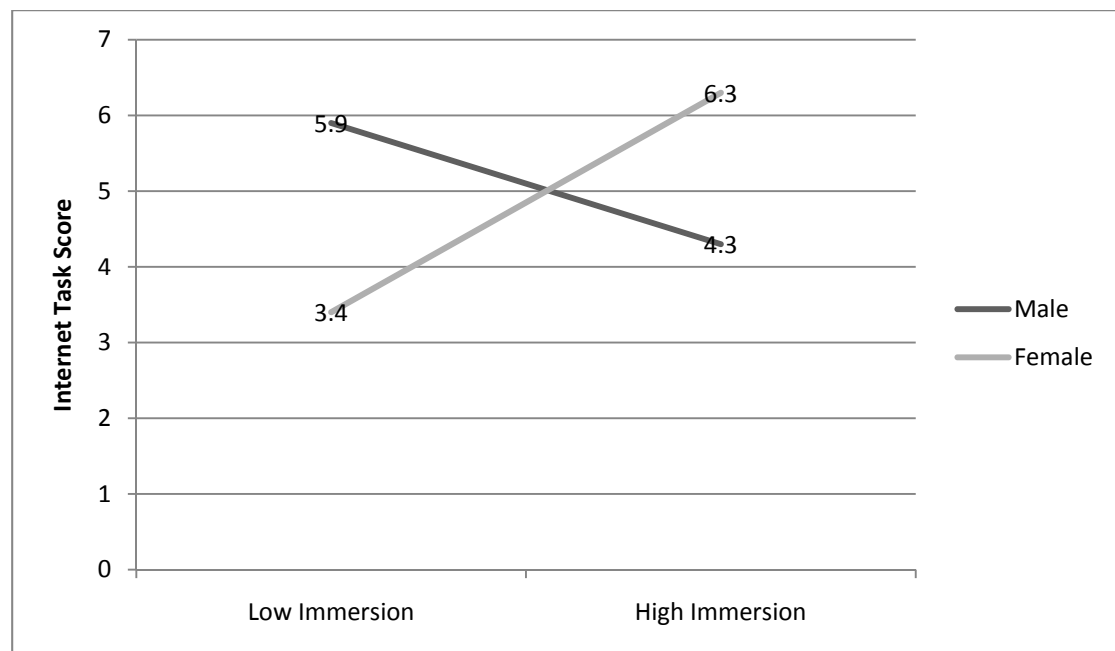


Figure 3. Internet task scores for males and females in the high and low immersion groups.

### *Research Task Behaviour*

Percentage of time spent on books was calculated during the research task (see figure 4) and although not statistically significant (marginal) it showed that low immersion individuals tended to spend more time using books compared to high immersion individuals (low  $M=49.9\%$ ,  $sd=35.8$ ; high  $M=32.3\%$ ,  $sd=28.3$ ). In addition, low immersion individuals were more likely to begin the task by using books rather than by using digital resources (see Figure 5).

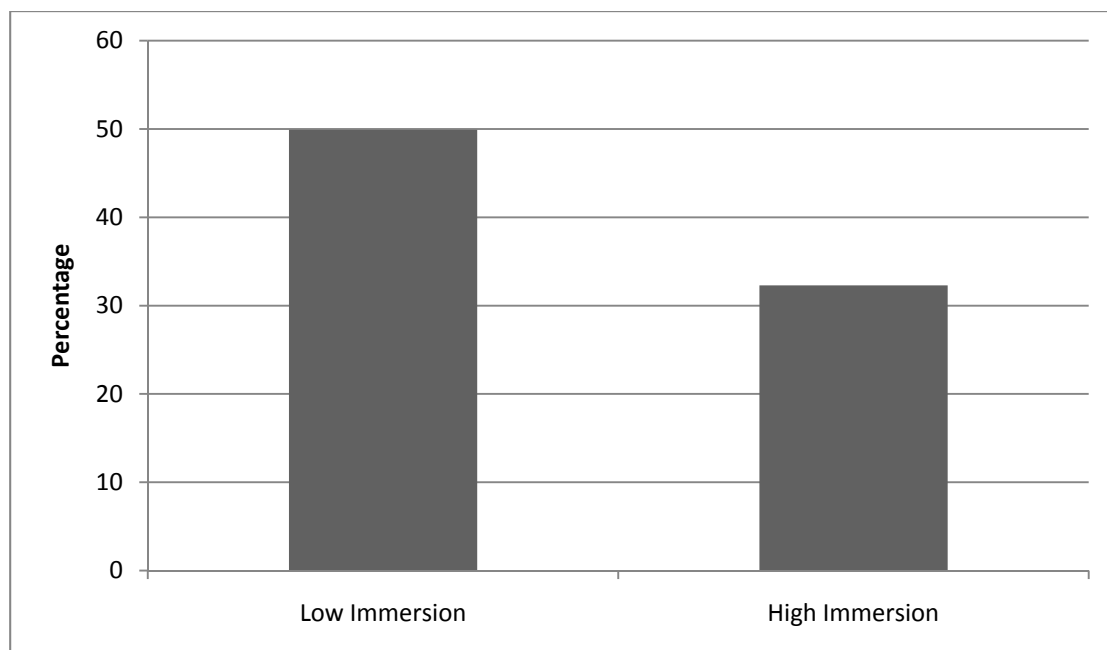


Figure 4. Percentage time spent on books by immersion group.

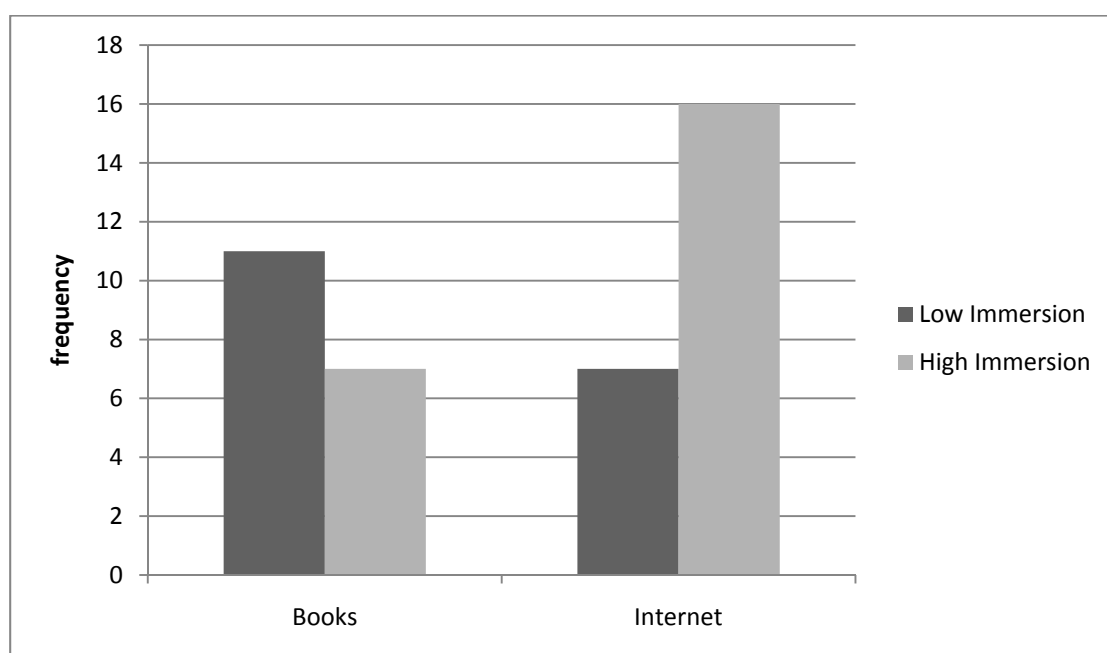


Figure 5. Number of students opting for books or internet first by immersion group.

### *Internet Behaviour*

Both the research task online behavior and internet task online behavior were examined and the following are some brief summaries typical of participant behaviour for high and low immersion students, names are fictitious.

**Andrea (High Immersion):** Easily accessed internet explorer and Google managing to navigate between the two with relative ease. Printed work relatively easily but had some minor problems printing discrete sections of the work; she opted to print it all. Her search strategies were poor. For example she used the following: “London”, “what important people in London”, “what important things happening in London”, such terms generated wholly irrelevant search results (given that she needed to find information about London in 1666). She also had problems choosing relevant search results even when some relevant ones had been generated. Many of the websites that she entered were referring to modern London rather than historical London. She spent a lot of time looking at a number of irrelevant websites that gave no useful information.

**Amelia (High Immersion):** Although she managed to open a browser she struggled to find an appropriate search engine. When she did she was unsure how to use it. For instance she initially typed search terms into the MSN Xtra ‘search for products’ search box. She then typed some terms into the correct MSN search box but failed to activate the search. For the internet task she managed access Google search but used the search term ‘electricity’, this yielded many modern (not historical) results. Consequently, she clicked on the ‘electricity commission’ website and began to explore this. Most of her time was spent looking at irrelevant websites. Finally she accessed Wikipedia and printed 7 pages from the ‘electricity’ entry (irrelevant information).

**Andrew (High Immersion):** He had no problems accessing a browser and Google search. However, once in Google search he had trouble searching for relevant information. He spent some time entering search terms into the search engine but then clicked on ‘book results’. This generated a number of results related to books. He then began to enter search terms into the engine and search within the images section of the engine. His initial search terms were reasonable, for example he used: “what transport do they use in 1666 in London?” but due to him using the wrong part of the search engine, results were poor. His search terms then degenerated to more general terms such as: “cars in London”, “cool cars”. He opened word and copied information (pictures of modern transport). For the internet task he used appropriate search terms in Google but his choice of search results was poor giving him information that was not very relevant, although some relevant search results were generated.

**Ben (Low Immersion):** Needed help to access a browser. Initially he tried to type “electricity” into the address bar of Internet Explorer (IE). He then typed: “who invented the battery” into IE’s web address bar. He then tried “electricity’ again in address bar. Finally, IE did a search for electricity and generated some search results. He quickly scanned the results and found nothing useful. He went back to the yahoo page in the browser and typed some new terms, this time into the correct search box and found what he wanted.

**Beverley (Low Immersion):** Initially needed help to get onto a browser. She then entered “1666 London” into the search box and scanned the results. Although some good results were generated she didn’t choose any of them. She then returned to Internet Explorer home page (Xtra MSN) and changed her search terms but this time spelled London incorrectly. This generated a number of results that were written in German. She selected one of the German websites to find that she couldn’t read the information. She spent a lot of time entering incorrectly spelled search terms into the search box and scanning the results with little success. Behaviour during the internet task was very similar. She entered incorrectly spelled words but didn’t utilize the ‘Did you mean...’ option that is generated in a search engine. Consequently, she spent the whole 15 minutes going backwards and forwards between the search engine and the results to no avail.

## **Discussion**

The first two research questions posed by this study asked whether high and low digitally immersed children differ in terms of their reasoning, attention and concentration. Results indicated that low immersion children had higher literacy reasoning levels than students who were more immersed in digital technology during their leisure time. Because this study is correlational it is difficult to interpret why this effect occurs. One might hypothesize that individuals with higher reasoning levels would have greater aptitude with technology and thus be attracted to its use during leisure time. Such a relationship has been suggested by researchers investigating older individual's uptake of technology, reporting that for older individuals' educational level or intellectual ability is positively correlated with the uptake of technology (Freese, Rivas and Hargittai, 2006). However, such a relationship does not seem to hold here with a younger population, more familiar with technology. It is not possible to definitively say whether these differences arise because of technology use per se, or whether it is due to already existent individual differences. However, it may be due to new technologies being attractive to individuals with lower reasoning ability and who are less inclined to traditional academic pursuits (e.g. reading, writing). New technologies are becoming easier to use by individuals of all ages and abilities and offer a popular outlet for those inclined to less intellectual pursuits, just as TV has done over the years. In addition, the immersion score used for this study does not differentiate between the types of activities engaged in. It would however, be interesting to investigate further whether the type of digital activity engaged in predicts literacy reasoning level further.

Similarly, results from the attention test indicated that high digital immersion individuals showed higher fluctuation rates (FR) indicating that these individuals were more prone to inconsistency within the actual attention test. In reality this means that high immersion individuals tended to attain high scores on some parts of the attention test and attain low scores on others, rather than perform consistently. This could be interpreted as a lack of motivation for the test. This could imply that individuals who are highly immersed in digital technology struggle to maintain motivation for more traditional paper and pencil test such as the one performed for this measure. Alternatively, this could reflect multi- tasking behavior often associated with teen technology use. High immersion individuals they may struggle to maintain concentration over longer periods of time, as was required for this test.

The third and fourth research questions asked whether high and low digitally immersed children differ in terms of their attainment on a research task and internet task. Results indicated that there were no differences for the research task when they were given a choice of materials to use that included traditional materials such as books and the internet.

However, a significant interaction effect emerged for the internet task. Results indicated that low immersion females performed worst and high immersion females performed best on this task. However, low immersion males performed best and high immersion males performed worst on the internet task. In addition, high and low immersion females showed greater differences compared with high and low immersion males. This effect shows that females who are more familiar with using technology excel compared with females who rarely use digital resources for a task that relies on such resources. This is no surprise. However, the trend for males is much more curious as it indicates the reverse effect. Given that the analysis controlled for reasoning ability it is unlikely that the pattern for males is due to low immersion males being of higher ability. One explanation for such a result is that low immersion and high immersion males undertake different types of digital engagement, with high immersion males concentrating on leisure time activities that are not useful for an internet search task such as this. However, low immersion males (although less immersed) may be engaging in more relevant digital activities that support the skills required for such a task.

Research question 5 asked whether high and low immersion children differ in terms of the way that they approach and use resources in a research task. Results indicated that low immersion individuals tended to spend more time using books than high immersion individuals and that they were also more likely to begin the task using books rather than digital resources. Children who are immersed in technology at home may be more inclined to utilize technology in other contexts such as this, when they are given a choice, and this was evident here. It should be emphasized that this difference between the time using books and time using the internet was not statistically significant. However, this may be explained by the following section describing behaviour on the internet.

Research question 6 asked whether high and low immersion children differ in terms of the way they approach and use the internet in an internet fact finding task. It was expected that the high immersion group who spend more time around digital technology would have a better grasp of using technology for this type of task. Observations indicated that although high immersion individuals were marginally more skilled at accessing and navigating the digital environment they were, in fact, no better at negotiating search engines to find appropriate information. Both high immersion and low immersion individuals were consistently poor at choosing the appropriate search terms and scanning and choosing the most appropriate search results, with both high and low immersion children struggling to find anything useful in the time allocated for the task that they were given. Therefore in relation to the previous research question although high immersion students were more eager to use the

internet (shown by the time spent on books and initial choice of medium) for the research task, once they were using the technology they soon found that they did not have the necessary skills to complete the task, often getting frustrated, and reverting to books as a last resort. Therefore it is likely that lack of skills by high immersion individuals with internet resources mediated the time spent on books.

Although many students are choosing technology as their preferred source of information, they appear to be lacking in skills appropriate to the task. Such skills are unlikely to evolve naturally and often need to be taught. However, it seems that primary schools rarely teach such skills, mainly opting for the more traditional skills of research using books. It is extremely important that schools address such skills much more pro actively, especially given that many of our children are now spending many hours on computers in their leisure time. Digital skills such as these are becoming an important life skill given that computers are so ubiquitous in society.

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